

New Hampshire Volunteer Lake Assessment Program

2002 Interim Report for White Oak Pond Holderness



NHDES
Water Division
Watershed Management Bureau
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OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **WHITE OAK POND** the program coordinators recommend the following actions.

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a and are naturally found in lake ecosystems, the chlorophyll-a concentration found in the water gives an estimation of the concentration of algae or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 ug/L.**

Similar to the summer of 2001, the summer of 2002 was filled with many warm and sunny days and there was a lower than normal amount of rainfall during the latter-half of the summer. The combination of these factors resulted in relatively warm surface waters throughout the state. The lack of fresh water to the lakes/ponds reduced the rate of flushing which may have resulted in water stagnation. Due to these conditions, many lakes and ponds experienced increased algae growth, including filamentous green algae (the billowy clouds of green algae typically seen floating near shore), and some lakes/ponds experienced nuisance cyanobacteria (blue-green algae) blooms.

The historical data (the bottom graph) show that the 2002 chlorophyll-a mean is ***slightly less than*** the state mean. Overall, visual inspection of the historical data trend line (the bottom graph) shows ***a variable*** in-lake chlorophyll-a trend, meaning that the concentration has ***fluctuated*** since monitoring began in 1989.

For the 2003 Bi-Annual Report, since the lake/pond will have been sampled for at least 10 consecutive years, we will conduct a statistical

analysis of the data. This will allow us to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Therefore, algal concentrations may increase when there is an increase in nonpoint sources of nutrient loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). It is important to continually educate residents about how activities within the watershed can affect phosphorus loading and lake quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

Two different weather related patterns occurred this past spring and summer that influenced lake quality during the summer season.

In late May and early June of 2002, numerous rainstorms occurred. Stormwater runoff associated with these rainstorms may have increased phosphorus loading, and the amount of soil particles washed into waterbodies throughout the state. Some lakes and ponds experienced lower than typical transparency readings during late May and early June.

However, similar to the 2001 sampling season, the lower than average amount of rainfall and the warmer temperatures during the latter-half of the summer resulted in a few lakes/ponds reporting their best-ever Secchi-disk readings in July and August (a time when we often observe reduced clarity due to increased algal growth)!

The historical data (the bottom graph) show that the 2002 mean transparency is **less than** the state mean.

It is interesting to note that as the chlorophyll-a concentration decreased from June to August this season, the transparency increased. We typically expect this inverse relationship in lakes. As the amount of algal cells in the water column decreases, the depth to which one can see into the water typically increases.

Overall, visual inspection of the historical data trend line (the bottom graph) shows **a slightly decreasing** trend for in-lake transparency, meaning that the transparency has **slightly worsened** since monitoring began.

As discussed previously, for the 2003 Bi-Annual Report we will conduct a statistical analysis of the data to objectively determine lake quality trends.

Typically, high intensity rainfall causes erosion of sediments into the lake/pond and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants are available from NHDES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

The historical data for the epilimnion (upper layer) show that the 2002 total phosphorus mean is **slightly greater than** the state median. Overall, visual inspection of the historical data trend line for the epilimnion shows **a relatively stable** total phosphorus trend since monitoring began.

The historical data for the hypolimnion (lower layer) show that the 2002 total phosphorus mean is **greater than** the state median. Overall, visual inspection of the historical data trend line for the

hypolimnion shows **a variable** total phosphorus trend, which means that the concentration has **fluctuated** since monitoring began.

It is important to point out the phosphorus concentration in the hypolimnion **steadily increased** from June to August this season. This suggests that the process of **internal phosphorus loading** is occurring in the pond. Please refer to the discussion of Table 9 and 10 for a more detailed explanation.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands. If you would like to educate watershed residents about how they can help to reduce phosphorus loading into the lake/pond, please contact the VLAP Coordinator.

TABLE INTERPRETATION

➤ **Table 2: Phytoplankton**

Phytoplankton populations undergo a natural succession during the growing season (Please refer to page 12 of the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds. An overabundance of cyanobacteria (previously referred to as blue-green algae) indicates that there may be an excessive total phosphorus concentration in the lake/pond, or that the ecology is out of balance. Some species of cyanobacteria can be toxic to livestock, pets, wildlife, and humans. (Please refer to pages 12 - 14 of the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria).

Unfortunately, the sample bottle that was used to collect the plankton sample this season broke before the sample could be analyzed. Therefore, there is no plankton data for this season. We apologize for this loss of data.

➤ **Table 4: pH**

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and

reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is 6.5, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to page 16 of the "Chemical Monitoring Parameters" section of this report.

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

➤ **Table 5: Acid Neutralizing Capacity**

Table 5 in Appendix B presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. For a more detailed explanation, please refer to page 16 of the "Chemical Monitoring Parameters" section of this report.

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) continues to remain **low** (4.47 mg/L as CaCO_3) and is **less than** the state mean of 6.7 mg/L (Table 5). Specifically, this means that the lake/pond is **"moderately vulnerable"** to acidic inputs (such as acid precipitation).

➤ **Table 6: Conductivity**

Table 6 in Appendix B presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. For a more detailed explanation, please refer to page 16 of the "Chemical Monitoring Parameters" section of this report.

The conductivity has **gradually increased** in the lake/pond and inlets since monitoring began (Table 6). Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity. It is possible that the lower than normal amount rainfall during the latter-half of the summer reduced tributary and lake flushing, which allowed pollutants and ions to build up and resulted in elevated

conductivity levels.

We recommend that your monitoring group conduct a stream survey and stormwater sampling along **Cocchiaro Inlet** so that we can determine what may be causing the increases. For a detailed explanation on how to conduct a stream survey and stormwater sampling, please refer to this year's "Special Topic Article" which is included in Appendix D of this report.

➤ **Table 8: Total Phosphorus**

Table 8 in Appendix B presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to page 17 of the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The total phosphorus concentration in the **Cocchiaro Inlet** was elevated (**55 ug/L**) on the **June** sampling event. The turbidity of the sample was also elevated (**6.52 NTUs**), which suggests that the stream bottom may have been disturbed while sampling (Table 11). When the stream bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting samples in the inlets, please be sure to sample where there the stream is flowing and where the stream is deep enough to collect a "clean" sample.

➤ **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**

Table 9 in Appendix B shows the dissolved oxygen/temperature profile(s) for the 2002 sampling season. Table 10 shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The dissolved oxygen concentration was again **low in the hypolimnion** at the deep spot of the lake/pond. As stratified lakes/ponds age, oxygen becomes **depleted** in the hypolimnion (the lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. Depleted oxygen concentration in the hypolimnion of thermally stratified lakes/ponds typically occurs as the summer progresses.

During this season, and many past sampling seasons the lake/pond has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (the lower layer) than in the epilimnion (the upper layer). These data suggest that the process of **internal phosphorus loading** is occurring in the lake/pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion (as it has been in July and August during many past seasons), the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column.

Unfortunately, low dissolved oxygen concentration and internal phosphorus loading are difficult problems to solve unless there is a source of funding to provide restorative actions. The most cost effective means to reduce the effect of internal phosphorus loading to the lake is to reduce the total phosphorus load from the watershed (external phosphorus) through a watershed phosphorus management plan.

Here are a few in-lake restoration treatments for internal phosphorus loading:

1. Hypolimnetic Aeration: Air (oxygen) is diffused into the hypolimnion to oxidize reduced anoxic (containing no oxygen) sediments. The system can run during periods of anoxia; sometimes June through August. This usually reduces internal phosphorus loading. The cost of this treatment would probably be in the \$9,000 to \$10,000 range (installed) with monthly electric costs. The costs would vary with the model purchased.

2. Aluminum Salts: Injection of aluminum salts into the hypolimnion would significantly decrease internal phosphorus loading and may restore oxygen for a year or two because of the toxicity of the aluminum to the bacteria that decompose organic matter. The cost will range from \$1000 to \$1500 per hectare (1 hectare = 2.471 acres) treated.

3. Bacteria Additives: Photosynthetic bacteria are added to the pond bottom to compete with algae for the available phosphorus. Photosynthetic bacteria have also been reported to break down bottom organic matter. There is little research on additives and the manufacturer claims they work best with aeration. Costs for additives may range from \$1000 to \$5000 per summer.

➤ **Table 11: Turbidity**

Table 11 in Appendix B lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to page 19 of the "Other

Monitoring Parameters” section of this report for a more detailed explanation.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake/pond, the biologist conducted a “Sampling Procedures Assessment Audit” for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor’s Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group performed **very well** while collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures. The biologist did identify one aspect regarding sample collection that the volunteer monitors could improve upon.

- **Anchoring at deep spot:** Please remember to use an anchor with sufficient weight and sufficient amount of rope to prevent the boat from drifting while sampling at the deep spot. It is difficult for the biologist to collect an accurate and representative dissolved oxygen/temperature profile when the boat is drifting. In addition, it is difficult to view the secchi disk and collect samples from the proper depths when the boat is drifting. Depending on the depth of the lake/pond and the wind conditions, it may be necessary to use two anchors!

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did a **very good** job when collecting samples this season! Specifically,

the members of your monitoring group followed the majority of the proper field sampling procedures when collecting and submitting samples to the laboratory. However, the laboratory did identify a few aspects of sample collection that the volunteer monitors could improve upon. They are as follows:

- **Sample “Cooling”:** Please remember to bring a cooler with ice when you sample. Samples should be put directly into the cooler and kept on ice until they are dropped off at the laboratory. This will ensure that samples do not degrade before they are analyzed.
- **Chlorophyll-a Sampling:** When collecting the chlorophyll-a sample using the composite method, please make sure to collect one Kemmerer bottle full of water at each meter from the starting point up to 1 meter from the surface. Specifically, in lakes with one or two thermal layers, begin at 2/3 the total depth and collect water at every meter up to the surface. In lakes with three layers, start at the middle of the middle layer (metalimnion) and collect water at every meter up to the surface.

Since your association collects the chlorophyll-a sample starting at 6 meters, you may want to use an **Integrated Sampler** to collect the chlorophyll sample. This method will likely be much faster for your association than conducting the composite method. For instructions on how to make an Integrated Sampler, please contact the VLAP Coordinator.

NOTES

- **Monitor’s Note (5/22/02):** Light foam on the water coming in to the pond observed. Moss on rocks and trillium observed.
- **Monitor’s Note (6/28/02):** Foam on water surface.
- **Laboratory Note (6/28/02):** Sediment observed in Cocchiaro Inlet sample bottle.
- **Laboratory Note (7/29/02):** The chlorophyll-a sample was not collected properly. Water was only collected at 6m, so a true composite sample was not collected.

USEFUL RESOURCES

Changes to the Comprehensive Shoreland Protection Act: 2001 Legislative Session, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/sp/sp-8.htm

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm

The Lake Pocket Book. Prepared by The Terrene Institute, 2000. (internet: www.terrene.org, phone 800-726-4853)

Organizing Lake Users: A Practical Guide. Written by Gretchen Flock, Judith Taggart, and Harvey Olem. Copies are available from the Terrene Institute (internet: www.terrene.org, phone 800-726-4853)

Proper Lawn Care in the Protected Shoreland: The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm

Sand Dumping - Beach Construction, WD-BB-15, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm

Swimmers Itch, WD-BB-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-2.htm

Use of Lakes or Streams for Domestic Water Supply, WD-WSEB-1-11, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/ws/ws-1-11.htm

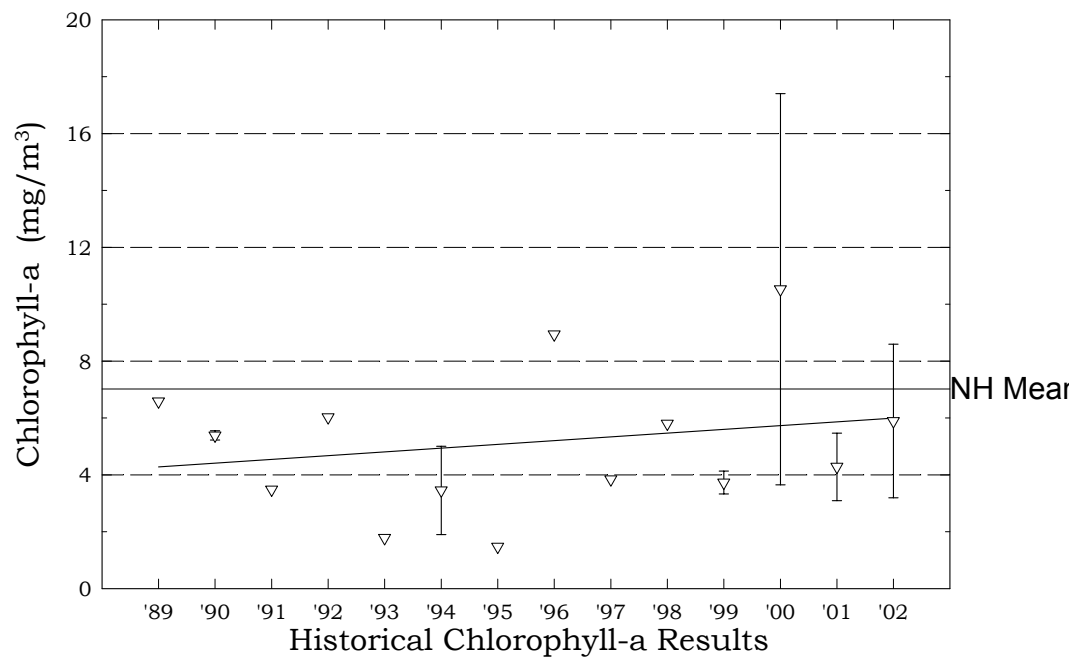
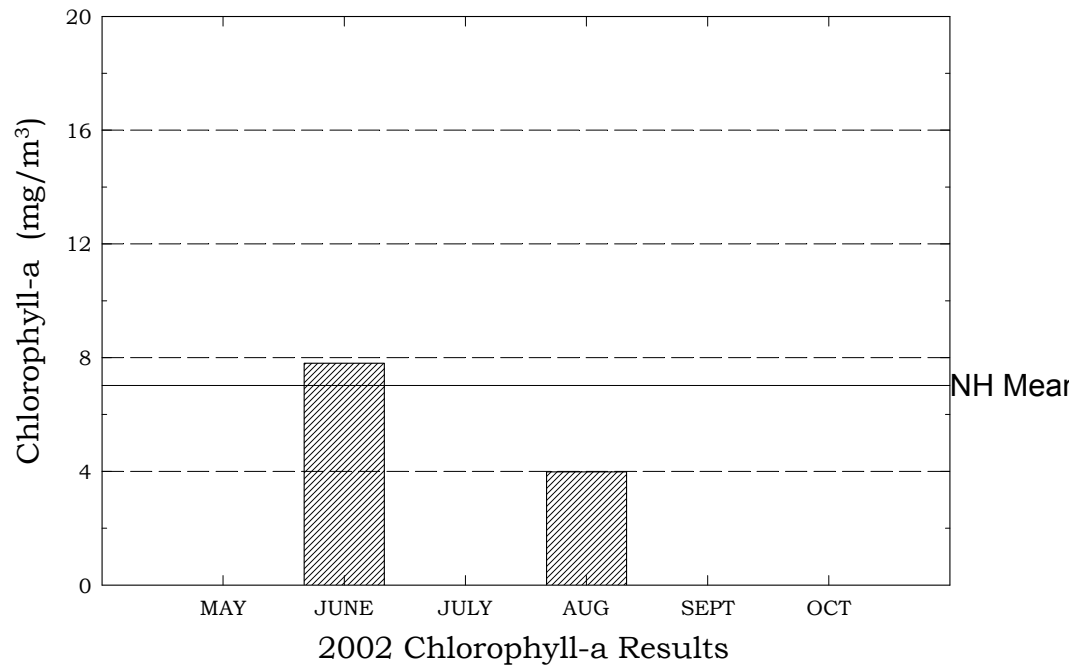
Water Milfoil, WD-BB-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-1.htm

Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, WD-BB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-4.htm

Appendix A: Graphs

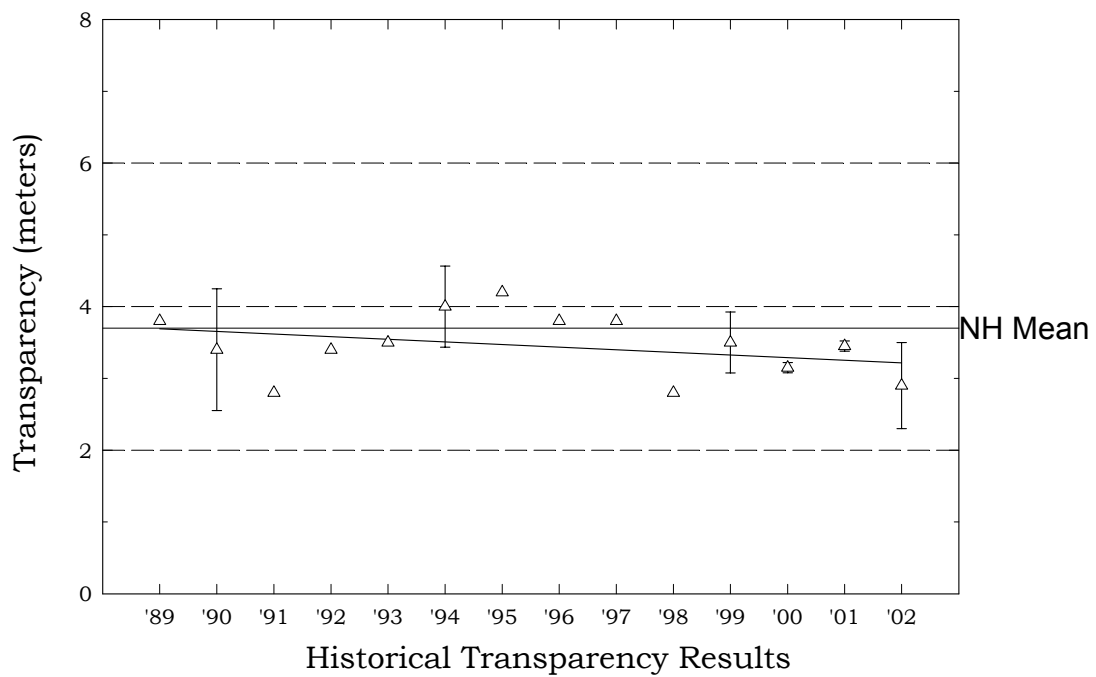
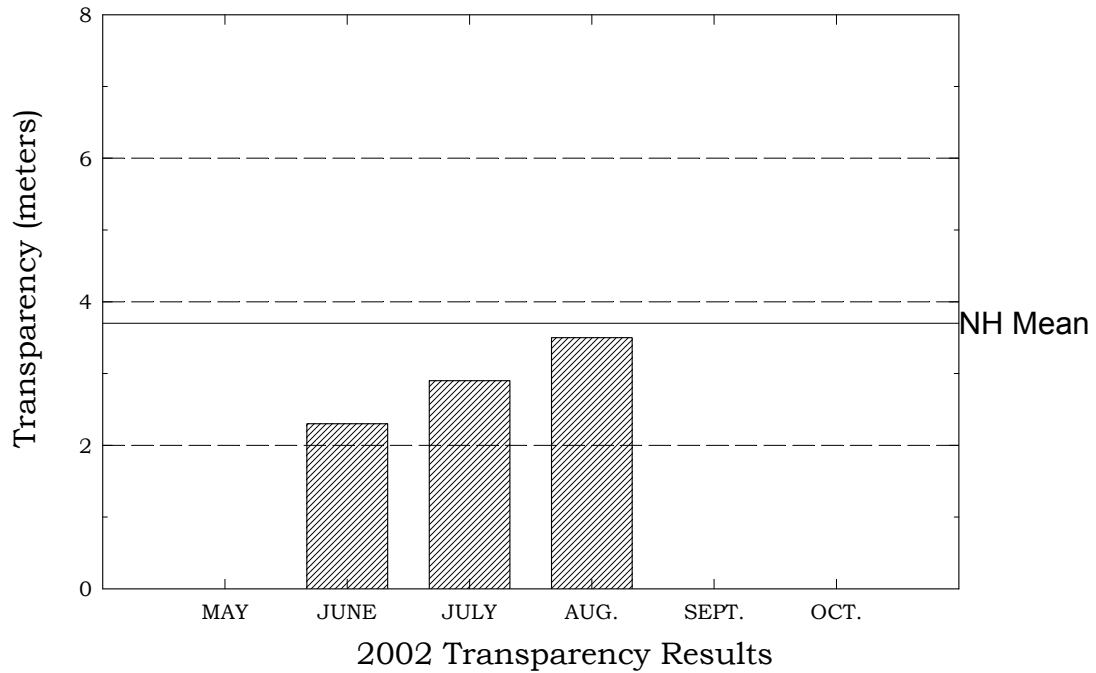
White Oak Pond, Holderness

Figure 1. Monthly and Historical Chlorophyll-a Results



White Oak Pond, Holderness

Figure 2. Monthly and Historical Transparency Results



White Oak Pond, Holderness

Figure 3. Monthly and Historical Total Phosphorus Data.

